

Option Pricing: A Flexible Tool to Disseminate Shared Savings Contracts

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Shared savings contracts between payers and providers are important features of many innovative healthcare payment and delivery models, including Accountable Care Organizations (ACOs) and medical homes.¹⁻⁴ These contracts incentivize cost containment by allowing providers to share in any savings they create, usually by paying them a percentage of the difference between observed and expected costs for their patient panels. However, providers generally do not pay an equivalent penalty if observed costs exceed expectations. This asymmetric risk distinguishes shared savings contracts from pure capitation or “global payment” arrangements in which providers stand to absorb gains and losses in equal measure.⁵

The Problem: Paying for Volatility

For a given patient, costs of care from year to year exhibit volatility, or unpredictable variation due to chance alone. Patients who are relatively healthy with low health expenditures in one year may become sick with high health expenditures in the next, and vice versa. Due to this random variation, observed costs for a provider’s patient panel can vary widely from expected costs, producing apparent savings in one year and cost overruns in the next. Therefore a substantial proportion of shared savings bonuses may be paid due to chance alone (“paying for volatility”), even if providers do nothing to contain costs. While random variation also can produce cost overruns, the resulting penalties will not counterbalance random rewards when shared savings contracts are asymmetric.

Faced with the prospect of paying for volatility, payers justifiably may avoid shared savings contracts: unless payers are confident that shared savings contracts will result in highly effective cost-containment efforts, random cost variation can undermine payers’ business case for such arrangements.⁴ Whether due to lack of confidence in cost-containment ability or aversion to financial risk, providers have resisted contracts that include penalties for cost overruns.⁶ Therefore to enable widespread adoption of shared savings contracts, we need tools to bridge the gap between providers who want protection against downside risk and payers who need a winning (or at least neutral) business proposition.

Objectives: Due to volatility in healthcare costs, shared savings contracts can create systematic financial losses for payers, especially when contracting with smaller providers. To improve the business case for shared savings, we calculated the prices of financial options that payers can “sell” to providers to offset these losses.

Study Design and Methods: Using 2009 to 2010 member-level total cost of care data from a large commercial health plan, we calculated option prices by applying a bootstrap simulation procedure. We repeated these simulations for providers of sizes ranging from 500 to 60,000 patients and for shared savings contracts with and without key design features (minimum savings thresholds, bonus caps, cost outlier truncation, and downside risk) and under assumptions of zero, 1%, and 2% real cost reductions due to the shared savings contracts.

Results: Assuming no real cost reduction and a 50% shared savings rate, per patient option prices ranged from \$225 (3.1% of overall costs) for 500-patient providers to \$23 (0.3%) for 60,000-patient providers. Introducing minimum savings thresholds, bonus caps, cost outlier truncation, and downside risk reduced these option prices. Option prices were highly sensitive to the magnitude of real cost reductions. If shared savings contracts cause 2% reductions in total costs, option prices fall to zero for all but the smallest providers.

Conclusions: Calculating the prices of financial options that protect payers and providers from downside risk can inject flexibility into shared savings contracts, extend such contracts to smaller providers, and clarify the tradeoffs between different contract designs, potentially speeding the dissemination of shared savings.

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Current Solutions

Tools to improve payers’ business case for shared savings contracts work in 2 general ways: reduce the

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Take-Away Points

Volatile healthcare costs and asymmetric shared savings contracts can create systematic financial losses for payers.

- Calculating the fair prices of “options” that payers can sell to providers to offset these losses can improve the business case for shared savings and clarify tradeoffs between contract designs.
- In a large sample of commercial health plan members, simulated option prices reached 3.1% of overall healthcare costs for providers with just 500 members. Prices were considerably lower for larger providers and more balanced contract designs.
- If shared savings contracts create 2% real savings, selling options may be unnecessary for most providers.

amount of random variation (ie, volatility) in costs, and make the contract more symmetric. To reduce random variation in costs, payers frequently require patient populations larger than a specified minimum threshold.⁴ For example, Medicare ACO demonstrations require 5000 or more patients (for the Shared Savings Program) and 15,000 for non-rural Pioneer ACOs ([Appendix A](#)).^{7,8} Due to the “law of large numbers,” larger patient populations have less random variation as a percentage of overall costs, thereby reducing payers’ risk of losses.⁹

Truncating cost outliers (patients with extremely high costs) also can reduce random variation in shared savings contracts. The Medicare Shared Savings Program truncates costs at the 99th percentile: for the purposes of calculating savings, the most expensive 1% of patients are considered to have costs equal to the patient at the 99th percentile.⁷ Both expected and observed costs are truncated, so while this method reduces the threat that cost outliers pose to providers, it also produces lower expected costs (ie, a tougher target for providers to beat).

To make shared savings more symmetric and improve the likelihood that bonuses are paid for real savings rather than volatility, some contracts include provisions that reduce the shared percentage of observed savings. For example, Medicare Pioneer ACO and Shared Savings Program contracts include both minimum savings rates that must be achieved before providers receive bonuses (ranging from 1 to 3.9%, depending on ACO size) and maximum caps on the amount of bonus any provider can receive (ranging from 10 to 15% of expected costs in the Medicare ACO programs).^{7,8}

Penalizing providers for cost overruns also makes shared savings contracts more symmetric. However, even in programs with downside risk for providers, some asymmetry generally persists. For example, when quality criteria are met the Medicare Pioneer ACO and Track 2 of the Medicare Shared Savings Program penalize providers 40% of the amount of cost overruns—less than the 60 to 70% bonuses triggered by savings.^{7,8}

Limitations of Current Solutions

By limiting shared savings contracts to large providers, payers may miss opportunities to engage ambitious smaller ones (like primary care practices transforming into medical homes) in cost containment. In addition, the relative strengths and weaknesses of current solutions can be unclear. For example, how does excluding outliers compare with requiring a minimum savings rate before sharing begins?

Is the answer the same for small primary care practices and large ACOs? What about combinations of these features? We believe a new tool can help evaluate a wide variety of shared savings arrangements and enable such contracts with small providers.

A New Solution: Selling Options

To allow a broad range of providers to enter asymmetric shared savings contracts without systematically disadvantaging payers, we propose to borrow a commonly used financial tool: the “call option.”¹⁰ When an investor wants to profit if a stock price climbs but not incur a loss if the price falls, he or she can purchase a call option that protects against downside risk. These options are not cost-free to the investor; instead, investors must pay for them.

Shared savings contracts present an analogous situation, and they might spread more rapidly if payers offer to sell “call options” to providers as a condition of entering such contracts. These options can be priced to counterbalance exactly payers’ expected losses due to random variation in healthcare costs, under any shared savings arrangement, with providers large and small. Once calculated, these option prices can clarify the business cases for both payers and providers, enabling construction of customized shared savings contracts when both parties are willing to negotiate.

METHODS

Overview

Using total cost data from a large sample of members in a commercial health plan, we simulated differences between observed and expected costs due to chance, calculated the resulting shared savings bonus payments (ie, payments for volatility), estimated the average financial loss to payers caused by these bonus payments, and priced a call option to offset these expected losses. We then extended the simulation to scenarios where shared savings contracts caused “real savings” (ie, reductions in costs due to providers changing their care).

■ Table 1. Key Dimensions of Shared Savings Contracts Simulated

Dimension	Definition
Percentage of savings shared	The percentage of savings that is paid to the provider in the form of a shared savings bonus.
Minimum savings rate	The minimum amount of savings, as a percentage of total expected costs, that a provider must surpass in order to receive a shared savings bonus.
First-dollar sharing	“First-dollar sharing” means that once the minimum savings rate is achieved, shared savings are calculated based on the full percentage of savings calculated. <i>Example:</i> If the minimum savings rate is 2% of expected costs and a provider achieves a 2.1% savings rate, the shared savings bonus will be based on the full 2.1% under first-dollar sharing. By contrast, if first-dollar sharing is not present, the shared savings bonus will be based on only the amount of savings exceeding the minimum savings rate (0.1% in this example).
Shared savings bonus cap	The maximum shared savings bonus for which a provider is eligible. Beyond this cap, additional savings produce no additional provider bonus.
Cost outlier truncation	For the purposes of calculating savings, the most expensive 1% of patients are considered to have costs equal to the 99th percentile of patients. Different degrees of truncation are possible (eg, replacing costs for the most expensive 2% of patients with costs for the 98th percentile).
Provider penalties for cost overruns	When observed costs exceed expected costs, providers pay a financial penalty to the payer (a percentage of the cost overrun). These penalties are the “shared losses” counterpoint to shared savings.

Data on Healthcare Costs

We obtained data on total healthcare spending in 2009 and 2010 for each continuously enrolled member of a large commercial health plan who was attributable to a pilot or control practice in a current medical home demonstration. By selecting patients attributable to primary care providers based on office visits, our patient sample consisted of those who might be included in shared savings contracts (and not those who would be impossible to attribute to a specific provider).⁷ To ensure that our simulations were not affected by the medical home demonstration, we excluded all patients attributed to pilot practices.

These spending data represented the total allowed amounts for all medical and prescription drug claims, including both the plan’s expenditures and any deductibles or coinsurance amounts paid by patients. Because we wanted to compare the financial impact of shared savings arrangements with fee-for-service payment, we excluded members of health plan products that featured other types of payment (eg, capitation). After exclusions, our study population comprised 77,364 patients.

Calculating Expected Costs

To simulate shared savings contracts, we first calculated the expected costs for each patient in 2010 based on his or her 2009 costs. To do this, we assumed perfect prediction of general medical inflation for the entire patient population. Our assumption of a population-level cost prediction model that cannot be improved allowed us to focus cleanly on how vola-

tility in patient-level costs affected shared savings contracts.

Of the Medicare ACO programs, our method for calculated expected costs is most similar to the Pioneer demonstration, which also performs risk adjustment using same-patient historical expenditures.⁸ However, because commercially insured populations tend to be younger and healthier than Medicare beneficiaries (among other differences between these populations), we did not attempt to replicate exactly any Medicare ACO contracts.

Shared Savings Contracts

We simulated a variety of shared saving contracts, each defined by 5 key dimensions (**Table 1**): percentage of savings shared; minimum savings rate, with and without first-dollar sharing; shared savings bonus cap; cost outlier truncation; and provider penalties for cost overruns. The main analyses varied these dimensions 1 at a time, but in supplementary analyses we explored their combinations. Although shared savings contracts can be limited to just 1 kind of spending (eg, just outpatient care),⁴ our scenarios included comprehensive costs of care across all providers and types of services.

Simulating Shared Savings and Calculating Option Prices

To estimate the financial impact of shared savings contracts, we performed a bootstrap simulation by randomly drawing samples of patients from the study population. We simulated providers of many sizes by drawing samples ranging

■ **Table 2.** Healthcare Costs of the Study Population

	2009 Costs	2010 Costs	Change, 2009 to 2010
Mean	\$6406	\$7166	\$760
Standard deviation	\$26,382	\$22,975	\$27,093
Cost Quintile	Percentage of Total Population Costs, ^a 2009	Percentage of Total Population Costs, ^a 2010	Percentage of Patients Who Switched Quintile, ^b 2009-2010
First (lowest cost patients)	0.5%	0.4%	53%
Second	2%	2%	70%
Third	5%	5%	72%
Fourth	13%	12%	66%
Fifth (highest cost patients)	79%	80%	50%

^aPercentage of total population. Due to rounding, percentages may not sum to 100%.
^bPercentage of patients in the corresponding 2009 cost quintile.

in size from 500 to 60,000 patients, with each sample representing a provider’s patient panel (or a “simulated provider,” for short).¹¹ We included panel sizes smaller than 2000 (a size that might be expected for a solo primary care provider) because in general, a single health plan rarely will enroll a provider’s entire patient panel. For example, a shared savings contract between a solo practitioner and a plan enrolling 25% of his or her overall panel might include only 500 patients. Within each size category, we repeated this process 10,000 times, effectively generating 10,000 simulated providers.

For each simulated provider, we calculated total costs per patient in 2009 and 2010. Within each provider size category, we used the average ratio of 2009 to 2010 actual costs per patient (across all 10,000 simulated providers) to calculate an expected 2010 total cost for each simulated provider. We then calculated, for each simulated provider, the difference between actual and expected 2010 costs. If negative, this difference was “savings;” if positive, it was a “cost overrun.”

This process preserved year-to-year random variation in costs at the provider level while guaranteeing perfect population-level cost prediction. In other words, the average savings across all providers was assumed to be zero in the base case, even though individual providers could have large simulated savings or cost overruns due to fluctuations in the costs for their specific patient panels. Because all patient samples were chosen at random, any difference between actual and predicted costs could only be due to chance—not providers altering their care.

For each simulated provider, we calculated the amount of shared savings (or penalty if a cost overrun was present) according to the terms of each shared savings contract scenario. We then calculated the average per patient financial impact to the plan within each provider size category. If the financial impact was negative, the magnitude of this impact was equal

to the fair price of a call option that would eliminate the plan’s average loss due to the shared savings contract.

Because shared savings contracts are designed to incentivize providers to generate cost savings, we repeated the above calculations assuming that the shared savings contracts caused providers to successfully alter their care, yielding 1% or 2% reductions in average 2010 per-patient costs.

Data management, simulations, and analyses were conducted using SAS software, version 9.2 (SAS Institute, Cary, North Carolina). This research was approved by the RAND Human Subjects Protection Committee.

RESULTS

In the study population, mean costs of care were \$6406 in 2009 and \$7166 in 2010 (Table 2). Consistent with others’ findings,^{12,13} the distribution of healthcare costs in the population was highly skewed, with the costliest 20% of patients accounting for approximately 80% of total expenditures in each year. Patient-level costs were also volatile; only 50% of the patients in the most costly quintile in 2009 remained in this quintile in 2010.

As expected, simulated option prices were greater for smaller providers than for larger providers (Table 3). In the shared savings “base case” (50% sharing of any savings, with no penalty for cost overruns), the fair prices of options were \$225 per patient (3.1% of total expected costs) for providers with 500 patients, compared with \$23 per patient (0.3%) for providers with 60,000 patients. Therefore, to turn a profit, a provider having only 500 patients would need to achieve an observed 6.2% savings rate, the minimum necessary for the shared savings bonus to offset the option price. However, even without altering their care after purchasing the option, 31% of such providers would be expected to profit due to chance

Option Pricing

■ Table 3. Fair Option Prices for Selected Shared Savings Contracts, Assuming No Real Savings

Model Type	Base Case	Minimum Savings	Minimum Savings 2	Bonus Cap	Outlier Truncation	Downside Risk
Savings shared	50%	50%	50%	50%	50%	60%
Minimum savings rate	0	2%	2%	0	0	0
First-dollar sharing	NA	Yes	No	NA	NA	NA
Shared savings bonus cap	None	None	None	10%	None	None
Cost overrun penalty	0	0	0	0	0	40%
Minimum cost overrun rate	NA	NA	NA	NA	NA	0
First-dollar penalizing	NA	NA	NA	NA	NA	NA
Cost overrun penalty cap	NA	NA	NA	NA	NA	None
Cost outlier truncation	None	None	None	None	99th percentile	None
Panel Size	Per-Patient Fair Option price ^a (% of total costs)					
500 patients	\$225 (3.10%)	\$223 (3.10%)	\$190 (2.70%)	\$193 (2.70%)	\$122 (1.70%)	\$90 (1.30%)
2000 patients	\$119 (1.70%)	\$115 (1.60%)	\$87 (1.20%)	\$113 (1.60%)	\$60 (0.80%)	\$47 (0.70%)
5000 patients	\$78 (1.10%)	\$73 (1.00%)	\$50 (0.70%)	\$78 (1.1%)	\$38 (0.50%)	\$31 (0.40%)
10,000 patients	\$57 (0.50%)	\$50 (0.70%)	\$30 (0.40%)	\$57 (0.80%)	\$27 (0.40%)	\$23 (0.30%)
60,000 patients	\$23 (0.30%)	\$11 (0.20%)	\$3 (0.05%)	\$23 (0.30%)	\$11 (0.20%)	\$9 (0.10%)
Panel Size	Percentage of Providers Receiving Net Bonus, After Purchasing Option					
500 patients	31%	31%	29%	33%	35%	42%
2000 patients	30%	31%	25%	31%	35%	40%
5000 patients	31%	32%	24%	31%	34%	41%
10,000 patients	31%	28%	22%	31%	34%	41%
60,000 patients	33%	11%	10%	33%	34%	43%

NA indicates not applicable; Minimum Savings 2, a shared savings model in which a minimum savings rate is applied without first-dollar sharing.
^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract.

alone (ie, the magnitude of their bonus would exceed the option price). From the payer’s perspective, these randomly generated provider profits would be offset, on average, by the options purchased by less lucky providers of the same size.

A 2% minimum savings rate that featured first-dollar sharing had little effect on option prices for smaller providers, decreasing the price for 500-patient providers from \$225 to \$223 per patient. Even for 10,000-patient providers, the 2% minimum savings rate reduced the option price from \$57 to \$50 per patient, with 28% of such providers profiting due to chance alone. However, this minimum savings rate halved the option price for 60,000-patient providers and reduced the rate of profits due to chance from 33% to 11% for these providers. Without first-dollar sharing, a 2% minimum savings rate produced lower option prices in all provider size categories.

A 10% bonus cap produced greater reductions in option prices for smaller providers (\$225 to \$193 for 500-patient providers) than for larger providers. Outlier truncation at the 99th percentile of patients reduced option prices by approximately 50% for providers in all size categories and slightly in-

creased the percentage of providers who would profit due to chance alone (with the magnitude of these profits being lower than without truncation [data not shown]).

Following Medicare ACO demonstration designs, we increased the shared savings rate to 60% and added a 40% penalty rate for cost overruns in the “downside risk” scenario.⁷ For the providers with 10,000 or fewer patients, this scenario had lower option prices than the others, and more providers profited due to chance alone. However, these random profits were balanced by random losses for unlucky providers [data not shown]. Combinations of these scenarios are presented in [Appendices B to D](#).

In scenarios assuming 1% and 2% real savings caused by the shared savings contracts (ie, decreases in average 2010 costs due to changes in care induced by the contract), option prices were considerably lower for all simulated contracts ([Tables 4 and 5](#)). In some of these scenarios, payers would have no reason to require larger providers to purchase an option, because the average savings would exceed losses due to chance. For the smallest providers, however, option prices re-

■ **Table 4.** Fair Option Prices for Selected Shared Savings Contracts, Assuming the Contract Causes 1% Real Savings

Model Type	Base Case	Minimum Savings	Minimum Savings 2	Bonus Cap	Outlier Truncation	Downside Risk
Savings shared	50%	50%	50%	50%	50%	60%
Minimum savings rate	0	2%	2%	0	0	0
First-dollar sharing	NA	Yes	No	NA	NA	NA
Shared savings bonus cap	None	None	None	10%	None	None
Cost overrun penalty	0	0	0	0	0	40%
Minimum cost overrun rate	NA	NA	NA	NA	NA	0
First-dollar penalizing	NA	NA	NA	NA	NA	NA
Cost overrun penalty cap	NA	NA	NA	NA	NA	None
Cost outlier truncation	None	None	None	None	99th percentile	None
Panel Size	Per-Patient Fair Option Price ^a (% of total costs)					
500 patients	\$169 (2.40%)	\$168 (2.30%)	\$133 (1.90%)	\$135 (1.90%)	\$75 (1.00%)	\$53 (0.70%)
2000 patients	\$64 (0.90%)	\$60 (0.80%)	\$29 (0.40%)	\$58 (0.80%)	\$14 (0.20%)	\$11 (0.20%)
5000 patients	\$24 (0.30%)	\$19 (0.30%)	NA	\$24	NA	NA
10,000 patients	\$4 (0.05%)	NA	NA	\$4 (0.05%)	NA	NA
60,000 patients	NA	NA	NA	NA	NA	NA
Panel Size	Percentage of Providers Receiving Net Bonus, After Purchasing Option					
500 patients	37%	37%	35%	40%	45%	46%
2000 patients	42%	41%	37%	43%	55%	51%
5000 patients	48%	39%	39%	48%	63%	54%
10,000 patients	56%	37%	37%	56%	68%	58%
60,000 patients	72%	26%	26%	72%	88%	72%

NA indicates not applicable; Minimum Savings 2, a shared savings model in which a minimum savings rate is applied without first-dollar sharing.
^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract. If the average financial impact of the shared savings contract would be a profit to the payer rather than a loss, then the payer will have no rationale for selling the option (and in fact might consider up-front bonuses to induce providers to enter the contract) and the option price is listed as NA.

mained positive, indicating payers’ persistent need to hedge against random cost variation.

DISCUSSION AND CONCLUSION

Shared savings contracts represent investments that are both volatile and asymmetric, a combination likely to create financial losses for payers. To address this problem, we have demonstrated a technique to simulate the financial impact of such investments on both parties and calculate “option prices” that exactly offset payers’ expected losses. We hope that by using this technique, payers and providers will be able to implement shared savings contracts in a flexible and customized way, finding the right combination of contract terms and option prices for each willing provider. From the standpoint of disseminating shared savings contracts, such an approach might be more attractive than barring smaller providers from participation, especially given the potential

for large ACOs’ market power to undermine cost-containment efforts.^{14,15}

How can payers operationalize option prices for shared savings contracts? We recommend that interested payers calculate option prices based on cost data from their own patients, the exact panel sizes of the providers with whom they contract, their own techniques for estimating benchmark costs, and their own informed opinions about whether the contract will induce real savings. The option prices presented in this paper are examples for 1 payer at 1 point in time. They are intended only as points of reference and to illustrate the financial impact of contract provisions such as minimum savings rates.

After calculating option prices, payers can present each interested provider with a menu of potential shared savings contracts tailored to the size and expected costs of the provider’s patient population. On this menu, the option can be operationalized as an entry fee transferred from the provider to the payer,

Option Pricing

■ Table 5. Fair Option Prices for Selected Shared Savings Contracts, Assuming the Contract Causes 2% Real Savings

Model Type	Base Case	Minimum Savings	Minimum Savings 2	Bonus Cap	Outlier Truncation	Downside Risk
Savings shared	50%	50%	50%	50%	50%	60%
Minimum savings rate	0	2%	2%	0	0	0
First-dollar sharing	NA	Yes	No	NA	NA	NA
Shared savings bonus cap	None	None	None	10%	None	None
Cost overrun penalty	0	0	0	0	0	40%
Minimum cost overrun rate	NA	NA	NA	NA	NA	0
First-dollar penalizing	NA	NA	NA	NA	NA	NA
Cost overrun penalty cap	NA	NA	NA	NA	NA	None
Cost outlier truncation	None	None	None	None	99th percentile	None
Panel Size	Per-Patient Fair Option Price ^a (% of total costs)					
500 patients	\$115 (1.6%)	\$113 (1.6%)	\$77 (1.1%)	\$78 (1.1%)	\$29 (0.4%)	\$17 (0.2%)
2000 patients	\$11 (0.2%)	\$7 (0.01%)	NA	\$4 (0.05%)	NA	NA
5000 patients	NA	NA	NA	NA	NA	NA
10,000 patients	NA	NA	NA	NA	NA	NA
60,000 patients	NA	NA	NA	NA	NA	NA
Panel Size	Percentage of Providers Receiving Net Bonus, After Purchasing Option					
500 patients	44%	44%	41%	46%	55%	52%
2000 patients	55%	46%	46%	56%	66%	57%
5000 patients	62%	46%	46%	62%	75%	62%
10,000 patients	67%	47%	47%	67%	83%	67%
60,000 patients	90%	49%	49%	90%	99%	90%

NA indicates not applicable; Minimum Savings 2, a shared savings model in which a minimum savings rate is applied without first-dollar sharing.
^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract. If the average financial impact of the shared savings contract would be a profit to the payer rather than a loss, then the payer will have no rationale for selling the option (and in fact might consider up-front bonuses to induce providers to enter the contract) and the option price is listed as NA.

with each fee paired to a specific combination of other terms including minimum savings rates, bonus caps, outlier truncation, and downside risk. Based on our simulations, we suspect that smaller providers will face relatively high option prices and therefore may gravitate toward contracts with lower option prices but less favorable other terms. We also suspect that providers of all sizes will choose contracts featuring outlier truncation, since this feature reduces option prices across the board.

The trickiest aspect of operationalizing option prices may be guessing the real effect of the contract on costs of care. In our simulations, we included real effects of zero, 1%, and 2% overall savings, finding that option prices were highly sensitive to the amount of real savings anticipated. Ultimately the “real effect” built into shared savings contracts may emerge from negotiations between payers and providers, who might draw initial savings estimates from evaluations of ACO demonstrations and related payment innovations.^{16,17}

Our study has limitations. First, our analysis was limited to

enrollees in 1 commercial health plan. Simulations based on other groups of patients may yield different results. Second, we did not investigate different ways to calculate expected costs. Many techniques can be used to predict future costs of care for a given patient population, and the simulations we present in this paper can be adapted to accommodate any desired cost prediction method. Third, our simulations did not include variation in the quality of care. Most shared savings contracts include quality criteria for providers to meet, and quality performance can affect the payment of shared savings bonuses.^{7,8} Our simulations assume all quality criteria are met. However, quality measures have their own variation due to chance,¹⁸ and simulating their ultimate impact on option prices is an area for future research.

With healthcare costs threatening to devour other parts of the national economy, efforts to contain these costs are increasingly important.¹⁹ An urgent response may require all hands on deck, including government and private payers as

well as providers of all sizes. Shared savings contracts, though promising, have been deployed narrowly. To include a broader swath of payers, providers, and patients, we advocate flexible approaches to shared savings. Option pricing may encourage greater flexibility, innovation, and dissemination of shared savings.

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Appendix A. Features of Shared Savings Contracts in 4 Demonstrations

Demonstration	Medicare Pioneer ACOs: Core Model	Medicare Shared Savings Program: Track 1 Initial Agreement	Medicare Shared Savings Program: Track 2 Initial Agreement	Northeast Pennsylvania Medical Home Pilot
Percent of savings shared ^a	60% in 1st year, 70% in 2nd-5th years	50%	60%	50%
Minimum savings rate	1%	2-3.9% (lower minimum with larger number of patients)	2%	\$3 per patient
First-dollar sharing ^b	Yes	Yes	Yes	No
Shared savings bonus cap	10%-15% of expected costs	10% of expected costs	15% of expected costs	No maximum
Percent of cost overruns shared ^a	40% in all years	0%	40%	0%
Minimum cost overrun rate	1%	NA	2%	NA
First-dollar penalizing ^b	Yes	NA	Yes	NA
Cost overrun penalty cap	10-15% of expected costs	NA	5-10% of expected costs	NA
Cost outlier truncation	99th percentile	99th percentile	99th percentile	Method not specified
Minimum number of patients	5000 if rural, 15,000 otherwise	5000	5000	No minimum specified

Sources: Centers for Medicare & Medicaid Services, Pioneer Accountable Care Organization (ACO) Model: Request for Application; Medicare Shared Savings Program: Accountable Care Organizations, Final Rule; Pennsylvania Governor’s Office of Health Care Reform, Participation Agreement For Participation in the Northeast Pennsylvania Rollout of the Pennsylvania Chronic Care Initiative.

NA indicates not applicable.

^aAssuming quality criteria are met maximally (ie, maximizes its performance score).

^b“First-dollar sharing” means that once the minimum savings rate is achieved, shared savings are calculated based on the full percentage of savings calculated. For example, if the minimum savings rate is 2% of expected costs and a provider achieves a 2.1% savings rate, the shared savings bonus will be 1.05% under first-dollar sharing (but only 0.05% if first-dollar sharing is not present).

Appendix B. Fair Option Prices for Shared Savings Contracts, Additional Scenarios Assuming No Real Savings

Model Type	Minimum Savings and Bonus Cap	Minimum Savings, Cap, and Outlier Truncation	Minimum Savings, Cap, and Downside Risk	Minimum Savings, Cap, Outlier Truncation, and Downside Risk
Savings shared	50%	50%	60%	60%
Minimum savings rate	2%	2%	2%	2%
First-dollar sharing	Yes	Yes	Yes	Yes
Shared savings bonus cap	10%	10%	10%	10%
Cost overrun penalty	0	0	40%	40%
Minimum cost overrun rate	NA	NA	2%	2%
First-dollar penalizing	NA	NA	Yes	Yes
Cost overrun penalty cap	NA	NA	10%	10%
Cost outlier truncation	None	99th percentile	None	99th percentile
<i>Panel size</i>	<i>Per-patient fair option price^a (% of total costs)</i>			
500 patients	\$191 (2.7%)	\$119 (1.7%)	\$52 (0.7%)	\$45 (0.6%)
2000 patients	\$109 (1.5%)	\$55 (0.8%)	\$35 (0.5%)	\$22 (0.3%)
5000 patients	\$73 (1.0%)	\$31 (0.4%)	\$29 (0.4%)	\$12 (0.2%)
10,000 patients	\$50 (0.7%)	\$17 (0.2%)	\$20 (0.3%)	\$6 (0.1%)
60,000 patients	\$11 (0.2%)	\$1 (0.0%)	\$5 (0.1%)	\$0.3 (0.0%)
<i>Panel size</i>	<i>Percentage of providers receiving net bonus, after purchasing option</i>			
500 patients	33%	36%	42%	43%
2000 patients	31%	34%	36%	34%
5000 patients	32%	25%	32%	25%
10,000 patients	28%	17%	28%	17%
60,000 patients	11%	1%	11%	1%

NA indicates not applicable.

^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract.

Appendix C. Fair Option Prices for Shared Savings Contracts, Additional Scenarios Assuming The Contract Causes 1% Real Savings

Model Type	Minimum Savings and Bonus Cap	Minimum Savings, Cap, and Outlier Truncation	Minimum Savings, Cap, and Downside Risk	Minimum Savings, Cap, Outlier Truncation, and Downside Risk
Savings shared	50%	50%	60%	60%
Minimum savings rate	2%	2%	2%	2%
First-dollar sharing	Yes	Yes	Yes	Yes
Shared savings bonus cap	10%	10%	10%	10%
Cost overrun penalty	0	0	40%	40%
Minimum cost overrun rate	NA	NA	2%	2%
First-dollar penalizing	NA	NA	Yes	Yes
Cost overrun penalty cap	NA	NA	10%	10%
Cost outlier truncation	None	99th percentile	None	99th percentile
<i>Panel size</i>	<i>Per-patient fair option price^a (% of total costs)</i>			
500 patients	\$133 (1.9%)	\$72 (1.0%)	\$9 (0.1%)	\$13 (0.2%)
2000 patients	\$54 (0.8%)	\$9 (0.1%)	NA	NA
5000 patients	\$19 (0.3%)	NA	NA	NA
10,000 patients	NA	NA	NA	NA
60,000 patients	NA	NA	NA	NA
<i>Panel size</i>	<i>Percentage of providers receiving net bonus, after purchasing option</i>			
500 patients	40%	46%	44%	47%
2000 patients	41%	42%	41%	42%
5000 patients	39%	37%	39%	37%
10,000 patients	37%	31%	37%	31%
60,000 patients	26%	12%	26%	12%

NA indicates not applicable.

^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract. If the average financial impact of the shared savings contract would be a profit to the payer rather

than a loss, then the payer will have no rationale for selling the option (and in fact might consider up-front bonuses to induce providers to enter the contract) and the option price is listed as NA.

Appendix D. Fair Option Prices for Shared Savings Contracts, Additional Scenarios Assuming The Contract Causes 2% Real Savings

Model Type	Minimum Savings and Bonus Cap	Minimum Savings, Cap, and Outlier Truncation	Minimum Savings, Cap, and Downside Risk	Minimum Savings, Cap, Outlier Truncation, and Downside Risk
Savings shared	50%	50%	60%	60%
Minimum savings rate	2%	2%	2%	2%
First-dollar sharing	Yes	Yes	Yes	Yes
Shared savings bonus cap	10%	10%	10%	10%
Cost overrun penalty	0	0	40%	40%
Minimum cost overrun rate	NA	NA	2%	2%
First-dollar penalizing	NA	NA	Yes	Yes
Cost overrun penalty cap	NA	NA	10%	10%
Cost outlier truncation	None	99th percentile	None	99th percentile
<i>Panel size</i>	<i>Per-patient fair option price^a (% of total costs)</i>			
500 patients	\$76 (1.1%)	\$25 (0.3%)	NA	NA
2000 patients	\$0.4 (0.0%)	NA	NA	NA
5000 patients	NA	NA	NA	NA
10,000 patients	NA	NA	NA	NA
60,000 patients	NA	NA	NA	NA
<i>Panel size</i>	<i>Percentage of providers receiving net bonus, after purchasing option</i>			
500 patients	46%	51%	47%	51%
2000 patients	46%	50%	46%	50%
5000 patients	46%	50%	46%	50%
10,000 patients	47%	50%	47%	50%
60,000 patients	49%	50%	49%	50%

NA indicates not applicable.

^a“Fair option price” is the price of a call option payers could sell to providers that would exactly offset the average financial loss to the plan resulting from a 1-year shared savings contract. If the average financial impact of the shared savings contract would be a profit to the payer rather

than a loss, then the payer will have no rationale for selling the option (and in fact might consider up-front bonuses to induce providers to enter the contract) and the option price is listed as NA.